

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>55568PCT si/mw</b>	<b>FOR FURTHER ACTION</b> See Form PCT/IPEA/416	
International application No. <b>PCT/SE 2003/001685</b>	International filing date ( <i>day/month/year</i> ) <b>30.10.2003</b>	Priority date ( <i>day/month/year</i> ) <b>30.10.2002</b>
International Patent Classification (IPC) or national classification and IPC <b>G21C 3/07, G21C 21/02, C22F 1/18</b>		
Applicant <b>Westinghouse Electric Sweden AB et al</b>		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
  - a. ☒ (sent to the applicant and to the International Bureau) a total of 4 sheets, as follows:
    - ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
    - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
  - b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) \_\_\_\_\_, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:
 

<input checked="" type="checkbox"/>	Box No. I	Basis of the report
<input type="checkbox"/>	Box No. II	Priority
<input type="checkbox"/>	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
<input type="checkbox"/>	Box No. IV	Lack of unity of invention
<input checked="" type="checkbox"/>	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
<input type="checkbox"/>	Box No. VI	Certain documents cited
<input type="checkbox"/>	Box No. VII	Certain defects in the international application
<input type="checkbox"/>	Box No. VIII	Certain observations on the international application

Date of submission of the demand  <b>20.04.2004</b>	Date of completion of this report  <b>01.12.2004</b>
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88	Authorized officer  <b>Lars Hennix/MP</b> Telephone No. +46 8 782 25 00

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE 2003/001685

## Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on a translation from the original language into the following language \_\_\_\_\_, which is the language of a translation furnished for the purposes of:

- ☐ international search (under Rules 12.3 and 23.1(b))  
☐ publication of the international application (under Rule 12.4)  
☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ the international application as originally filed/furnished

☒ the description:

pages 1-10 \_\_\_\_\_ as originally filed/furnished

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

☒ the claims:

pages \_\_\_\_\_ as originally filed/furnished

pages\* \_\_\_\_\_ as amended (together with any statement) under Article 19

pages\* 11-14 received by this Authority on 24.09.2004

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

☒ the drawings:

pages 1 \_\_\_\_\_ as originally filed/furnished

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_

☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages \_\_\_\_\_

☐ the claims, Nos. \_\_\_\_\_

☐ the drawings, sheets/figs \_\_\_\_\_

☐ the sequence listing (specify): \_\_\_\_\_

☐ any table(s) related to the sequence listing (specify): \_\_\_\_\_

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages \_\_\_\_\_

☐ the claims, Nos. \_\_\_\_\_

☐ the drawings, sheets/figs \_\_\_\_\_

☐ the sequence listing (specify): \_\_\_\_\_

☐ any table(s) related to the sequence listing (specify): \_\_\_\_\_

\* If item 4 applies, some or all of those sheets may be marked "superseded."

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE 2003/001685

**Box No. V** Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

## 1. Statement

Novelty (N)	Claims	<u>1-19</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-19</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-19</u>	YES
	Claims		NO

## 2. Citations and explanations (Rule 70.7)

Amended claims were filed together with a statement on 2004-09-24

The following documents were cited in the International Search Report:

D1: EP1225243 A1  
D2: EP0198570 A1  
D3: US5648995 A1  
D4: US4775428 A1  
D5: WO0161062 A1

The cited documents represent the general state of the art.  
The invention defined in claims 1-19 is not disclosed by any of these documents.

The cited prior art does not give any indication that would lead a person skilled in the art to the claimed method of producing a cladding tube for nuclear fuel, the claimed use of a cladding tube, the claimed cladding tube, the claimed fuel assembly for a nuclear pressure water reactor. Therefore, the claimed invention is not obvious to a person skilled in the art.

Accordingly, the invention defined in claims 1-19 is novel and is considered to involve an inventive step. The invention is industrially applicable.

Claims

1. A method of producing a cladding tube for nuclear fuel for a  
5 nuclear pressure water reactor, which method comprises the following steps:

formation of a tube which at least principally consists of a  
cylindrical tube component (1) of a Zr-based alloy, where the  
alloying element, except for Zr, which has the highest content in the  
10 alloy is Nb, wherein the Nb content in weight percent is between 0.5  
and 2.4 and wherein no alloying element, except for Zr and Nb, in  
said alloy, has a content which exceeds 0.3 weight percent,  
characterized in that after that the cladding tube has been formed  
according to the above and after possible rolling steps with heat  
15 treatments between them, the cladding tube is finally annealed at a  
temperature and during a time such that said tube component (1) is  
partly recrystallized but not completely recrystallized, wherein said  
final anneal is carried out such that the degree of recrystallization in  
said tube component (1) is higher than 5% and lower than 95%.

2. A method according to claim 1, wherein said final anneal is  
carried out such that the degree of recrystallization in said tube  
component (1) is higher than 40%.

3. A method according to any of the preceding claims, wherein  
25 the final anneal is carried out at a temperature which is lower than  
550°C.

4. A method according to any of the preceding claims, wherein  
30 the final anneal is carried out at a temperature which is between  
400°C and 540°C.

5. A method according to any of the preceding claims, wherein  
the final anneal is carried out during 1h to 6h.

6. A method according to any of the preceding claims, wherein  
35 before said final anneal, the method comprises the following steps:

a bar of said Zr-based alloy is formed;

this bar is heated to between 900°C and 1300°C and is thereafter quenched, preferably in water;

5 a billet is extruded from the bar after heating to between 500°C and 900°C;

the billet is cold rolled to a tube in at least two steps, with heat treatments between them at between 550°C and 650°C.

7. A method according to any of the preceding claims, wherein  
10 the Nb content in said alloy is between 0.8 weight percent and 1.2 weight percent.

8. A method according to any of the preceding claims, wherein  
15 said alloy contains between 800ppm and 1700ppm O.

9. A method according to any of the preceding claims, wherein  
said alloy contains between 50ppm and 600ppm Fe.

10. A method according to any of the preceding claims, wherein  
20 said alloy in addition to Zr contains 0.8 weight percent to 1.2 weight percent Nb, 50ppm to 600ppm Fe, 800ppm to 1700ppm O, less than 250ppm C, less than 150ppm Si, less than 1000ppm S and in addition to that only impurities of a content which does not exceed  
25 that which is normally accepted in Zr or Zr alloys for applications in nuclear reactors.

11. Use of a cladding tube produced according to the method  
according to any of the preceding claims in a fuel assembly for a  
nuclear pressure water reactor.

12. A cladding tube for nuclear fuel for a nuclear pressure water  
reactor, which cladding tube at least principally consists of a  
cylindrical tube component (1) of a Zr-based alloy, where the  
alloying element which, except for Zr, has the highest content in the  
35 alloy is Nb, wherein the Nb content in weight percent is between 0.5 and 2.4 and wherein no alloying element, except for Zr and Nb, in said alloy, has a content which exceeds 0.3 weight percent, wherein

said tube component (1) has been finally annealed such that it has a structure such that it is partly recrystallized but not completely recrystallized and wherein the degree of recrystallization in said tube component (1) is higher than 5% and lower than 95%.

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13. A cladding tube according to claim 12, wherein the degree of recrystallization in said tube component (1) is higher than 40%.

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14. A cladding tube according to any of the claims 12 and 13, wherein the Nb content in said alloy is between 0.8 weight percent and 1.2 weight percent.

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15. A cladding tube according to any of the claims 12-14, wherein said alloy contains between 800ppm and 1700ppm O.

16. A cladding tube according to any of the claims 12-15, wherein said alloy contains between 50ppm and 600ppm Fe.

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17. A cladding tube according to any of the claims 12-16, wherein said alloy in addition to Zr contains 0.8 weight percent to 1.2 weight percent Nb, 50ppm to 600ppm Fe, 800ppm to 1700ppm O, less than 250ppm C, less than 150ppm Si, less than 1000ppm S and in addition to that only impurities of a content which does not exceed that which is normally accepted in Zr or Zr alloys for applications in nuclear reactors.

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18. A fuel assembly for a nuclear pressure water reactor, comprising:

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a plurality of cladding tubes (1) according to any of the claims 12-17 filled with nuclear fuel suitable for such cladding tubes (1) for a nuclear pressure water reactor.

19. A fuel assembly according to claim 18, comprising:

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a top plate (4),  
a bottom plate (5),

a plurality of guide tubes (3) for control rods, which guide tubes extend between the top plate (4) and the bottom plate (5), and

5 a plurality of spacers (2) arranged for maintaining said cladding tubes (1) in position in the fuel assembly and at suitable distances from each other.